

PRE-PEELED POTATOES FOR COMMERCIAL USE

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## Pre-Peeled Potatoes for Commercial Use<sup>1/</sup>

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The pre-peeled potato industry is based upon the ability of the operator to deliver peeled potatoes of high quality directly to the consumer. Centralization of effort, specialized equipment, and large-volume production make savings possible which justify development of the operation. In addition, the successful operator can provide greater uniformity of product and thereby guarantee quality.

At present, several processors are serving institutions and restaurants. With improvement in techniques, they may be able to sell peeled and packaged potatoes to the retail trade also. Home preparation of potatoes, which involves time, labor, and disposal of waste, may be a factor in the trend toward lower per capita consumption. If ready-prepared potatoes were available, possibly many consumers would serve them more frequently and in larger portions.

This circular presents information on the processing of pre-peeled potatoes. While some unpublished research findings are included, this publication is not a report of completed experimental work. It is, rather, a summing up of available information gathered as a preliminary step in a continuing research project, only recently initiated.

### Origin and History of Pre-Peeling

Pre-peeled fresh fruits and vegetables have been produced commercially for at least 19 years. Early practice consisted of delivery of product (sliced apples and peeled potatoes) immersed in water in metal containers to institutional and restaurant customers. Common salt was sometimes added to the water to help control discoloration. As the delivery of large quantities of water with the product became more and more impractical, means were sought whereby quality of peeled potatoes could be maintained without submersion in water.

The principal quality deterioration that occurs in peeled potatoes on standing is a typical reddish-brown discoloration. The problem of controlling this discoloration had been encountered earlier and technological advances had been made years before the pre-peeling industry was conceived.

In an early U. S. Department of Agriculture publication,<sup>2/</sup> Wiley recommended exposure of peeled potatoes to the fumes of burning sulfur as a means of preventing discoloration during the process of dehydration. It is possible that sulfiting was recommended for dried potatoes even before that time. Since

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<sup>1/</sup> Report of a study made under the Research and Marketing Act of 1946.

<sup>2/</sup> Wiley, H. W., U. S. Department of Agriculture Bulletin 58, The Manufacture of Starch from Potatoes and Cassava (1900).

Wiley's publication, several patents have been granted on methods of preventing discoloration of foodstuffs, utilizing the same active principle (sulfur dioxide) or a near derivative.<sup>3/</sup>

Sulfite ion (or sulfur dioxide) apparently acts both as an enzyme inhibitor and an antioxidant in arresting the typical color development of a cut potato surface. Since the discoloration is enzymatic in nature, attempts have been made to control it with other enzyme inhibitors or inactivators. To date, with the exception of those pertaining to sulfur dioxide and related compounds, no satisfactory results have been published.

Treatment of peeled potatoes by dipping in acidified solutions has offered slight protection against discoloration. Acids of antioxidant nature, such as ascorbic acid, have been more promising. Sulfhydryl compounds, such as cysteine, have been suggested and are also considered to be promising possibilities. Investigations are continuing in an effort to find better treatments than are now available to prevent discoloration of peeled potatoes.

In the meantime, a number of commercial enterprises have been initiated for the sale of pre-peeled potatoes. Preservation methods used generally involve sulfur dioxide or a related compound. In most instances modifications of published methods have been applied and many are being maintained as trade secrets.

A fairly complete description of one process for the preparation of pre-peeled potatoes has been published.<sup>4/</sup> However, the plant described is no longer in operation. More recently publicity has been given to a pre-peeling venture<sup>5/</sup> claiming treatment with an odorless, tasteless compound to prevent discoloration and spoilage for several days. Details of the method are not available.

#### Purchase of Raw Material

Authorities generally agree that potato quality is determined only with due regard to ultimate use. A high-quality potato for chipping or boiling is not necessarily of high quality for baking or French frying. The processor of pre-peeled potatoes must be aware of requirements of his customers and must demand suitable quality from his supplier.

Since changing markets will affect sales and profits, decisions on purchase commitments will have an important effect on the commercial operation. Sales analyses and production cost data will be helpful in making such decisions and should be accumulated from the outset of activity.

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<sup>3/</sup> A review of some of the patents directly and indirectly concerned with prevention of discoloration in food products is attached as Appendix A.

<sup>4/</sup> Havighorst, C. R., "Pre-peeled Potatoes from Mechanized Line," Food Indus. 20, 999-1010 (1948).

<sup>5/</sup> Callahan, T., "A New Wrinkle for Restaurants," Wall Street Journal (Pacific Edition) 41(2):1 (July 5, 1949).

In general, the processor of pre-peeled potatoes will purchase in sufficient quantity to demand the right to sample lots before buying. In this respect, he can offer a valuable service to his customers who, buying in small lots, cannot always insist upon this privilege.

A quality-control system should be established by the processor. Selection of a representative sample from a given purchase lot and appraisal by simple cooking tests would be a minimum control technique. Preparation of boiled, mashed, and French-fried potatoes by common household or restaurant methods would probably be a sufficient basis for quality appraisal for persons experienced in the field.

As financial considerations dictate, the potatoes as purchased will be either sorted and graded or not. In either case, sorting to further refinement will probably be advisable. Large, well-formed potatoes of the proper varieties will be selected for sale without peeling, generally at a premium price, for baking potatoes. Spoiled and cull potatoes will be withdrawn for disposal. The rest will be available for processing. If ungraded potatoes are purchased, size grading and re-sale of small sizes may be good practice, since high peeling losses and inconvenience of handling may decrease profits appreciably.

#### Storage of Raw Material

Storage of raw material may well affect products to be made from pre-peeled potatoes. It is well known that cold storage allows an increase in reducing-sugar content which may make potatoes unsatisfactory for French frying and chipping. Conditioning such potatoes by storage for a week or two at 70°F. will often restore a better starch-to-sugar ratio. Sprouting inhibitors have been used to maintain quality during storage at temperatures at which the increase in reducing sugars does not take place. These results show sufficient promise to be considered as a distinct possibility for protecting quality in commercially stored lots of potatoes.

In early experiments at the Western Regional Research Laboratory, the effect of raw storage for short periods has not been found significant in pre-peeling operations. Potatoes were peeled, sulfited, and stored at 40°F. after one-month storage at 34°, 40°, and 50°F. Differences in processing operations and storage stability were negligible among the samples. The effects of prolonged storage are being studied.

#### Washing Raw Material

It is frequently convenient to move potatoes from the point of unloading or from bin storage to the vicinity of the washer by means of a flume. Stones and much of the dirt can be removed in fluming. The potatoes are conveyed or dumped manually into the entry chute of the washer.<sup>6/</sup> A potato washer consists of a

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<sup>6/</sup> Manufacturers of food-processing equipment may be found in standard trade references such as the following: Thomas's Wholesale Grocery and Kindred Trades Register, Thomas Publishing Co., New York, N. Y.; Food Industries

Catalogs, Pre-Filed Buying Information on Machinery, Equipment Supplies, and Ingredients for Food Processors, McGraw-Hill Publishing Co., Inc., 330 West 42nd Street, New York 18, N. Y.; Western Canner and Packer, Statistical Review and Year Book Number, Miller-Freeman Publications of California, 121 Second St., San Francisco 5, Calif.; Food Packer, Directory and Buyers Guide, Vance Publishing Corp., 13 North Clark St., Chicago 2, Ill.; Quick Frozen Foods, Annual Equipment Directory, E. W. Williams Publications, Inc., 82 Wall St., New York 5, N. Y.; Food Products Directory, W. J. McCamman, Publisher, 1202 Hearst Building, San Francisco 3, Calif.

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long trough fitted with a screen or slat false bottom divided into three or more compartments. Each compartment is supplied with running water, drainage connections for overflow, and means for discharging dirt and small stones. Large stones, which may be present if fluming is not employed, are removed periodically by hand. A shaft with agitator paddles runs the length of the washer. The agitation by the paddles causes the potatoes to rub against one another, thus effectively removing adhering dirt. The paddles move the potatoes continuously through the washer, and a lift paddle at the end of each section transfers the potatoes from one compartment to the next.

Equipment should be available for the mechanical washing of potatoes, even though normal purchases might be of a grade and condition that would require little or no washing prior to peeling.

#### Peeling Methods

Producing peeled potatoes at a reduced total cost is a fundamental basis of the pre-peeling industry. Several methods of peeling, some more wasteful than others, are commonly known, and many variations of these methods are in use. Several of the available systems are briefly discussed below, and a selected bibliography on peeling methods is attached as Appendix B.

Basically, one or more of the following three actions are involved in commercial potato peeling: (1) physical removal of the skin (plus some other tissue) by cutting or abrading the tuber surface, (2) loosening the skin by thermal shock (or cooking) and washing, rubbing, or brushing the affected surface, and (3) loosening the skin by chemical action on the tissue and washing, rubbing, or brushing the loosened surface.

Hand-peeling or paring is generally inefficient because of high labor cost and peeling loss. Continuous and batch-type abrasion peelers also use the first principle. In the batch method, the peelings are removed by rotation of the potatoes in a drum equipped with a wavy-shaped, revolving metal disc having a rough silicon carbide finish. The wall of the drum is also frequently coated with an abrasive. About one bushel of potatoes is loaded into the peeler in each charge, and peeling is completed in approximately one minute. Water is sprayed on the potatoes continuously to wash away the fragments of peel as they are loosened. The continuous abrasion peeler consists of several compartments through which the potatoes pass. Each compartment contains a series of silicon carbide rolls that rotate at high speed, effectively removing the skins from the potatoes.

As with hand peeling, the peeling losses are high and render abrasion peeling relatively inefficient. Irregular shapes and non-uniformity of size add to peeling losses. In spite of these disadvantages, abrasion peeling is widely used in the pre-peeling of potatoes, because it avoids the cooked layer that results when methods involving high temperatures are used.

Peeling methods using high-pressure steam, superheated steam, explosion, hot brine, flame, radiant heating, and hot oil depend upon thermal shock or surface cooking to loosen the corky layer of potatoes. Removal of the skin is then accomplished by washing, brushing, or rubbing. By some of these methods almost none of the starchy tissue is removed with the skin, and peeling losses are at a minimum. Irregular surfaces are uniformly peeled and eyes are well cleaned out by this type of process. Equipment cost must be carefully considered. Labor costs may be reasonable, since very little trimming is necessary after the mechanical operations.

The principal disadvantage of peeling methods involving use of high temperature is the cooking of the potato surface. Gelatinization of the starch occurs to a depth of about 1/16 inch under favorable operating conditions, to as much as 1/2 inch with some types of equipment or with poor control. Beneath the cooked surface heat activation of enzymes occurs, with consequent heavy discoloration. Pre-heating, immediate blanching, and treating with chemicals to inactivate or inhibit the enzymes have proved effective in controlling this darkening.

In some potato products the existence of a cooked surface layer is a serious quality defect. Under some conditions of storage, steam-peeled potatoes will develop a tough surface layer that will detract from their quality as a food product.

The common lye-peeling methods utilize the chemical attack on adhesive plant material below the skin, as well as thermal shock, to accomplish removal of skin. Boiling alkali solution containing about 20 percent sodium hydroxide (about 225°F.) will penetrate potato skin sufficiently in one minute to loosen it. Solutions of concentrations higher than 20 percent will penetrate in a matter of seconds at the boiling point, which increases with concentration of the solution. The time required for penetration increases markedly as the alkali concentration is decreased below 20 percent.

Lye peeling is generally better adapted than high-pressure steam peeling to continuous operation with less costly equipment. However, as normally used, the disadvantage of cooking the surface layer is not avoided. Additional disadvantages are: (1) hazard to personnel handling the caustic and (2) the possibility of yellow flavone discoloration from high pH, unless alkali is thoroughly washed from the product. In some cases, it may be necessary to use a weak acid dip to remove last traces of alkali from the potatoes.

Lye peeling at a temperature below that of gelatinization of potato starch might accomplish peeling without cooking the surface layer. Woodroof devised such a method to peel peaches for freezing without cooking the surface. He found that a two-minute immersion in 10 percent lye solution at 150°F.

desired results.<sup>7/</sup> Experiments have indicated that ten to fifteen minutes in such a bath, followed by thorough washing and scrubbing, were required to remove skins from potatoes. However, only five to six minutes' immersion in a 20 percent lye solution at 165°F. was sufficient for reasonably easy removal of skins from Russet Burbank potatoes (3 to 4 months' storage). The lye-affected tissue is removed by rigorous washing, leaving a peeled potato with no cooked surface layer.

While this low-temperature lye-peeling method overcomes the principal disadvantages of methods using high temperatures, it has not been exploited commercially, and there may be unknown factors that will cause difficulty in large-scale operations. The increased time required will necessarily increase the investment in equipment for processing a given amount of potatoes compared with other lye-peeling methods. Temperature control is necessary to prevent any cooking of the surface. Also, it is possible that a more efficient washer will be required.

#### Washing and Sorting

In regard to washers, following the peeling operation, those equipped with brushes must be used with caution because of difficulty in cleaning and maintaining adequate sanitary levels. High-pressure sprays and mildly abrasive rubber or metal rolls would be simpler to clean and might be adequate.

Regardless of method of peeling, it is necessary to pass the potatoes over an inspection table. Any bad potatoes are then removed manually, decayed spots are cut out, and dark areas that may remain around the eyes are trimmed.

#### Preparation for Various Uses

Pre-peeled potatoes can be prepared in several forms: sliced for French frying, whole for boiling or mashing, cut in large pieces for mashing, and diced for hash brown potatoes. The small uneven pieces left from cutting or slicing may, in part, be used for hash brown potatoes, thus reducing losses of material that would otherwise be wasted.

#### Treatment to Prevent Discoloration

As previously noted, treatment of peeled potatoes with sulfur dioxide or a related compound is the most generally used method to prevent discoloration. Other chemicals may accomplish the same result and perhaps some can be combined with sulfur dioxide, enabling effective use of reduced concentrations by synergistic action. Such a reduction would be desirable, since even in minimum concentrations required to control darkening, sulfur dioxide is detectable by sensitive persons. The literature contains few references, aside from patents on techniques for preventing the discoloration of fresh, peeled potatoes (see Appendix A).

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<sup>7/</sup> Woodroof, J. G., Georgia Agricultural Experiment Station Bulletin 163, Preserving Fruits by Freezing. I. Feaches (1930).

Early experiments at the Western Regional Research Laboratory and the Eastern Regional Research Laboratory have demonstrated some effective treatments to control discoloration of peeled potatoes. Minimum treatments that prevent darkening for ten to fifteen days in sealed containers at 40°F. are as follows: (1) 15- to 30-second dip in 1.7 percent sodium bisulfite; (2) 5-minute dip in 0.1 to 0.2 percent sodium bisulfite; (3) 10-minute dip in 0.5 percent sodium or potassium metabisulfite.

A 5- to 15-minute dip in 0.25 percent sulfur dioxide was found adequate to prevent discoloration of potato slices for eight hours exposed to air. Dipping fresh potato slices in dilute solutions of sodium chloride, citric acid, lactic acid, hydrochloric acid, and gallic acid, or packing in vacuum or inert atmosphere gave much less protection against discoloration than sulfur dioxide or sulfite solutions.

Experiments are under way in an attempt to find other effective methods. As previously mentioned, ascorbic acid has been found fairly effective, but only in rather high concentration. It is hoped that progress in these experimental endeavors will be rapid enough to allow early publication of results of value to the industry. At present, however, no treatment has been published that seems more effective than sulfur dioxide.

Labeling is required by the Federal Food and Drug Administration when sulfur dioxide or salts producing sulfur dioxide in food products are used in foods destined for interstate commerce. The use of sulfur dioxide is allowed, provided the preservative is not added to conceal damage or inferiority. In addition, several States have placed restrictions on use of sulfites. Local offices of such agencies should be consulted concerning any intended process before operations are begun on a commercial scale.

With regard to consumer acceptance, there has been ample precedent for the use of sulfur dioxide and sulfites in foodstuffs for the purpose of preservation. These substances have been used for many years in canned cherries, fruit salads, jams, preserves, jellies, marmalades, sirups, molasses, sauces, candied fruits, and dried fruits to protect the original light color. Sulfites have also been used in the growing of wines to control spoilage bacteria and wild yeasts before fermentation is started. During the last war, sulfur dioxide came into use in the dehydration of blanched, diced potatoes after it was found that a residual content of about 300-500 parts per million of the compound prevented browning during drying and preserved the color and palatability of the dried product in storage. With this successful history as a foundation, it seems reasonable to expect that as a preservative, sulfur dioxide would be acceptable in the small concentrations (approximately 50 parts per million for the whole potato) required to prevent discoloration.

Because of differences in raw material, equipment used for treating the potatoes, and conditions prevailing in storage of the treated potatoes up to the time of consumption, it is not possible to give specific directions regarding concentration of treating solutions and immersion time to fit all cases. Development of a general technique, followed by careful control with minor adjustments to compensate for possible variations, will be required in a commercial undertaking.

### Packaging<sup>8/</sup>

One of the most critical unsolved problems is a satisfactory package. Experiments have demonstrated the importance of packaging in the maintenance of high quality in stored, peeled potatoes. To prevent drying of the potato surface and the discoloration and texture changes that accompany the drying a moisture-resistant container that does not allow free passage of gases seems essential. Texture change becomes extremely important when potatoes are to be used for mashing, since hard portions will remain in the product in the form of lumps.

Re-usable containers without liners: Sanitation will present a difficult problem with any type of re-usable containers without a liner, because potatoes are an excellent medium for microbial growth. Any particles of potato remaining in the container will provide a place for growth and thus might contaminate the next potatoes placed in the container. Thorough washing to remove all particles, followed by heat or chemical sterilization, will be required for complete sanitation.

To be re-usable, a container must withstand washing and sterilization and in addition withstand sulfur dioxide, if used. Information received thus far indicates that none of the steel containers with any of the protective linings now available will withstand the combination of these two factors. Aluminum containers might be satisfactory, but the high initial cost probably makes them too expensive. Wax-coated fiberboard drums could serve as re-usable containers if sanitation requirements can be met and if they will stand handling and sterilization operations. A tightly fitting slip-over lid is probably sufficiently moisture-tight. Prices on 10-gallon drums are about \$0.75 to \$1.00 each, depending on weight of materials used.<sup>9/</sup> The use of a burlap bag laminated with plastic film as a re-usable container has been considered. It is doubtful that the sanitation requirements could be met conveniently and economically with this type of container.

Re-usable containers with disposable liners: In this type of packaging the liner prevents moisture loss and protects the outer container from contamination. Ability to meet sanitation requirements, protection of product, and cost of packaging are favorable if proper combinations of materials are used.

Possible outer containers include wooden boxes and fiberboard cartons and drums. No instance has come to our attention of commercial use of drums, possibly because cost is higher than for the other two types. Both fiberboard cartons and wooden boxes are used commercially. Wooden boxes (apple boxes) cost approximately 40 cents each. Fiberboard cartons are appreciably cheaper, but cost varies with style selected. No data are available on expected life of either.

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<sup>8/</sup> The section on packaging in this report was prepared with the help of V. F. Kaufman.

<sup>9/</sup> Package cost estimates for this report were made in the San Francisco area in the spring of 1949. It is recognized that such estimates are no more than a rough indication of relative costs, subject to considerable change.

The type of liner should be selected for degree of protection deemed necessary by the processor. These liners range from folded sheets of waxed paper to various types of heat-sealed bags. Folded sheets of waxed paper give very limited protection from moisture loss if the potatoes are stored for a considerable time. However, this type of liner has been used commercially. Heat-sealed bags of plastic materials give superior resistance to moisture loss but are somewhat more expensive. Approximate prices of these liners for boxes holding 40-50 pounds of peeled potatoes have been quoted as follows: waxed paper, for folding to cover inside of box, 4 cents; waxed paper bag, 6 cents; transparent, non-rigid, plastic film bags, 12 to 18 cents.

One-trip containers: For pre-peeled potatoes "one-trip" packages are probably limited to multiwall paper bags with moisture-resistant linings. Within this limitation, there is wide range of choice. Several instances have been reported of commercial use of this type of container.

Approximate prices of multiwall paper bags to handle 50 pounds of pre-peeled potatoes have been quoted as follows: waxed-paper-lined, 12 cents; glassine-lined, coated, 14 cents; water-resistant, plastic-film-lined, 18 to 24 cents.

The full value of moisture-resistant packaging materials cannot be realized without a proper seal. Some processors have been using a simple fold to close waxed-paper linings used in apple boxes. Heat sealing is recommended for Cellophane. Some waxed papers cannot be readily heat-sealed, and a taped, stitched, or stapled seam will be required. Taping involves an additional cost of 1 to 2 cents per bag for the tape required. It should give a tighter seam than either stitching or stapling.

Package sizes must meet the needs of customers. Quantity of potatoes required per cooking period and storage facilities available at the customer's establishment will be important factors. Differing requirements among customers and demand for uniformity may be in conflict and must be resolved in view of specific cases, rather than by general decision.

#### Storage of Peeled Potatoes

In storage, peeled potatoes are considerably less stable than unpeeled potatoes. Susceptibility to microbial spoilage is very much greater, and precautionary measures are required to prevent the souring, sliming, and gas formation that might result. A storage temperature not exceeding 40°F. is advisable for pre-peeled potatoes and probably essential for any but very short storage periods, unless other methods become available for spoilage control.

The storage life of pre-peeled potatoes depends upon several factors, including raw material, processing technique, sanitary control, packaging technique, and storage temperature. It has been possible, in laboratory experiments, to hold peeled potatoes for more than two weeks at 40°F. without apparent quality deterioration. A commercial venture probably should not be considered if it cannot guarantee quality maintenance for at least a week. Under these conditions, one should strive to limit time between processing and consumption

to three days. At least a four-day margin will be required as protection against inadequate storage facilities in the customer's establishment as well as lack of experience on the part of persons handling the product. Storage time can be limited by use of dated packages and replacement of customer's stocks held beyond a maximum time. Such a service would involve an operational loss that must be compensated for by value received in terms of selling price, good will, and guaranteed quality.

#### Delivery to Customers

Delivery schedules must be arranged to meet fully the needs and convenience of customers. Because of storage and spoilage considerations, deliveries are generally required at least every other day and in many instances daily.

If routes are short, refrigeration in delivery trucks may not be required. For longer deliveries a pre-cooled, insulated truck bed or some other means of maintaining low product temperature may be necessary. The potatoes should not be allowed to reach elevated temperatures (60° to 70°F.) during delivery.

#### Sanitary Aspects

As in any food industry, the processing of pre-peeled potatoes must be carried out with appropriate sanitary precautions. The product is perishable and highly susceptible to microbial contamination, particularly if heat treatment is involved, as in steam or lye peeling. The heat-killed layer of tissue is more likely to ferment than raw surface of an abrasion-peeled potato.

Routine clean-up and avoidance of recirculation of wash water and treatment baths are helpful in avoiding high build-up of spoilage organisms that may be responsible for undue contamination of product. Education of operating personnel in matters of plant sanitation and personal hygiene is necessary to maintain a sanitary operation. Routine sanitation surveys by supervising personnel should be instituted as a control measure.

Even with the most scrupulous clean-up feasible under normal operating conditions, absolute freedom from contamination cannot be achieved. It is essential for this reason to handle the product so that such contamination as exists will not multiply to the stage of being a menace to health or a detriment to the aesthetic appeal of the product.

Pre-peeled potatoes should be held at low temperature (35°-45°F.) from the time they are processed until they are prepared for consumption, in order to prevent rapid development of spoilage contaminants. (An alternative method may be treatment with unobjectionable bacteriostatic compounds. This field has not been completely explored and more information may be obtained as a result of continuing research.)

#### Waste Disposal and Utilization

Waste disposal from food processing is a major problem and must be arranged with due consideration for local conditions. For pre-peeling potatoes, the quantity and kind of waste are largely dependent upon processing methods used.

Of particular importance are peeling and washing. Estimates of waste for a given plant must be made in advance for comparison with waste disposal facilities that have been, or could be, made available in the proposed plant area.

Part of the waste from pre-peeled potatoes has potential value as stock feed or other by-products. The peel removed by a lye-peeling operation is useless for this purpose. The pulpy mass contains little digestible nutrients, and satisfactory removal of caustic would be uneconomical. At present, the commercial utilization of waste potato peel falls short of the potential.

#### General Considerations and Conclusions

As indicated in the introduction and throughout the body of this report, much remains to be accomplished in the technical development of the pre-peeled potato process.

A real problem has been encountered by several processors in the surface hardening of steam-peeled potatoes. Several factors that may contribute to this condition are now being studied at the Western Regional Research Laboratory. It is possible to say, on the basis of preliminary research, that the package used and conditions of storage after peeling seem to have an important bearing on surface hardening. The influence of variety has also been demonstrated in comparisons of White Rose with Russet Burbank potatoes. The former is somewhat less susceptible to the development of a hard surface.

The effect of various treatments of pre-peeled potatoes on product flavor is another important phase of work that is continuing. Some commercial packers have reported outbreaks of off-flavor development. Answers to such problems have not been available.

The effect of sulfiting on product flavor will continue to receive attention, as will microbiological studies to determine more precise limitations for proper treatment and storage of pre-peeled potatoes.

#### Appendix A

Some of the patents pertaining to pre-peeling process (prevention of discoloration of foodstuffs):

In 1918 H. G. C. Fairweather was granted a patent (Brit. Pat. 118,466) involving treatment of peeled white potatoes in 3 percent salt (NaCl) solution at a temperature below 165°F., followed by steam blanching, to prevent discoloration during the drying process.

Apparently the use of sulfur dioxide in the bleaching and preservation of foods was a widely accepted trade practice in 1922 when I. Hochstadter patented a process (U.S. Pat. 1,412,523) to remove excess sulfur dioxide from food products by treatment with hydrogen peroxide.

C. D. Draper was granted a patent in 1934 (U.S. Pat. 1,948,877) on a process to prevent discoloration of peeled Irish potatoes by exposure to fumes of burning sulfur. It should be noted that this is essentially the technique recommended by Wiley some 34 years earlier. (See Origin and History of Pre-Peeling, above.)

In 1935 a patent (U.S. Pat. 2,011,465) was granted to A. K. Balls and W. S. Hale for the use of cysteine and other sulfhydryl compounds to inhibit the discoloration of fruits and vegetables.

In 1936, W. H. Ewell's patent (U.S. Pat. 2,028,970) covered a process of preventing discoloration in fruits and vegetables by dipping in a cold, saturated solution of carbon dioxide and packaging the product in an impervious envelope. The carbon dioxide solution removes oxygen from the product and the air-tight package prevents air from reaching it during storage. The patent includes the use of sulfur dioxide to prevent discoloration during the process before treatment with the carbon dioxide solution.

W. H. Wilson in 1940 (U.S. Pat. 2,215,446) claimed origin of use of sodium hyposulfite, hyposulfurous acid, sodium thiosulfate, and sodium metabisulfite in the prevention of discoloration of butts of lettuce and other produce.

In 1941, J. L. Williams was granted a patent (U.S. Pat. 2,241,436) for the application of sulfur dioxide by dipping in a solution of sodium metabisulfite. He claimed better control of treatment and reduction in amount of active agent absorbed and in depth of penetration into the food product.

J. L. Phillips was granted a patent in 1943 (U.S. Pat. 2,336,291) for the use of sodium bisulfite and triethanol amine as discoloration preventives for lettuce.

In 1947, R. F. Matarazzo was granted a patent (U.S. Pat. 2,420,322) for a technique of processing pre-peeled potatoes. The process involved brief dipping of peeled potatoes in a solution of sulfur dioxide (from 0.5 to 6.0 percent, preferably about 1 percent), packaging in an air-tight container, and holding the product under refrigeration. A successful commercial enterprise of several years' standing is based on this process.

A patent (U.S. Pat. 2,166,072) related to this general subject was granted A. C. Pope and W. E. Pfleger in 1939 for a method of introducing sulfur dioxide into solution. Liquid sulfur dioxide enters the in-flowing water through a specially constructed injector. Only a small amount of gas escapes from solution and discomfort to operating personnel is reduced.

#### Appendix B

##### Selected Bibliography on Peeling Methods for Potatoes:

###### Steam Peeling:

1. Anon, "Vapor Peeler," Western Packing News 18(12):6 (Mar. 10, 1949).
  2. Anon, "Continuous Steam Peeler," Food Indus. 17(5):561 (May, 1945).
  3. Anon, "Steam Peeling of Root Vegetables Operating at Beech-Nut Packing Co.," West. Canner and Packer 36(6):43-5 (May, 1944).
  4. Anon, "Dehydrated Food Production Stepped up with New Peeling Process," Fruit Prod. Jour. 23(10):302-4 (1944).
  5. Eidt, C. C., and MacArthur, M., "The Peeling of Fruits and Vegetables for Processing," Food in Canada 4(7):31-5 (1944).
  6. Friselle, F., Jr., "Peeling of Fruits and Vegetables Open to Eight Different Methods," West. Canner and Packer 35(10):20-1 (Sept., 1943).
  7. Hubbard, D. M., "Keep 'Em Drying," The Canner 98(5):16 (Jan. 1, 1944).
  8. Mazzola, L. C., "Potato Peeling Methods Analyzed and Appraised," Food Indus. 18(11):1708-9; (12):1874-6 (1946).
  9. Wager, H. G., et al., "The Drying of Potatoes," Food Mfr. 20(8):289-93 (1945)
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10. Doolin, C. R., "Flame Peeler Cuts Loss in Potato Chip Plant," Food Indus. 17(1):21 (Jan., 1945); also see references 5, 6, and 8.
  11. Henneter, G. T., "Device for Peeling Agricultural Products," U.S. Pat. 2,340,923 (1946).
  12. Burton, L. V., "Dehydrator Uses New Technics," Food Indus. 15(11):59 (Nov., 1943); also see references 5, 6, 8, and 9.

###### Lye Peeling:

13. Anon, "Factors Affecting Lye Peeling," Brown Instrument Co., Food Process Instrumentation No. 8, Inst. Data Sheet No. 32-6.
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15. Caldwell, J. S., et al., "Variety and Place of Production as Factors in Determining Suitability for Dehydration in White Potatoes," The Canner 97(3):30; (4):14; (5):15 (June 19, 26, and July 3, 1943).

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